

ATTORNEY'S DOCKET NO. UCN-004  
PATENTS

**UNITED STATES PATENT APPLICATION**

**OF**

**DANIEL M. FALKOFF, MORTON TARR AND PHILIP J. LENTINI**

**FOR**

**TELEPHONY SERVICES PROVIDER ARRANGEMENT FOR HOME AREA NETWORK**

Certificate of Express Mailing

Express Mail Mailing Label No. EK 904 503 705 US

Date of Deposit March 31, 2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office To Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D. C. 20231.

By Richard A. Jordan

Richard A. Jordan

## INCORPORATION BY REFERENCE

U. S. Patent Application Serial No. 09/365,726, filed August 3, 1999, in the name of Richard Edson, entitled "Multi-Service In-Home Network With An Open Interface" and assigned to the assignee of this application, incorporated by reference.

U. S. Provisional Patent Application Serial No. 60/193,813, filed March 31, 2000, in the name of Theodore F. Tabloski, et al., entitled "Home Area Network" and assigned to the assignee of this application, incorporated by reference.

## FIELD OF THE INVENTION

The invention relates generally to the field of user-premises or home area networking, to allow different types of systems and/or communications devices to utilize one in-home network to communicate with each other and to access a number of external communication services, and more specifically to systems and methods of connecting telephone sets to the public switched telephony network (PSTN) through a home area network, which can also provide other telephony services.

## BACKGROUND OF THE INVENTION

U. S. Patent Application Serial No. 09/365,726, filed August 3, 1999, in the name of Richard Edson, entitled "Multi-Service In-Home Network With An Open Interface" (hereinafter "the Edson application") and U. S. Provisional Patent Application Serial No. 60/193,813, filed March 31, 2000, in the name of Theodore F. Tabloski, et al., entitled "Home Area Network" (hereinafter "the Tabloski, et al., application") describe various embodiments of an in-home

1 network and server therefor that provides a number of services. It is desirable to interface  
2 the home's telephony devices to the server to facilitate provision by the server of a number  
3 of telephony services, such as call answering and recording of messages, in such a manner  
4 so that, in the event of a power failure or malfunction of the server, the home's telephony  
5 devices will still be connected to the PSTN to facilitate receiving and placing of telephone  
6 calls.

### 7 SUMMARY OF THE INVENTION

8 The invention provides a new and improved system and method of connecting  
9 telephone sets to the public switched telephony network (PSTN) through a home area  
10 network to facilitate, inter alia, provision of a variety of telephony services.

11 In brief summary, the invention provides a telephony services provider arrangement for use  
12 in connection with a server in a home area network, the telephony services provider arrangement  
13 being configured to provide at least one telephony service in connection with at least one telephony  
14 device connected to the server. The telephony services provider arrangement comprises a telephone  
15 interface and a control module. The telephone interface is configured to, in a telephone link  
16 connected state, connect the at least one telephony device to a telephone link and, in a telephone link  
17 disconnected state, disconnect the at least one telephony device from the telephone link to facilitate  
18 provision of the at least one telephony service to the at least one telephony device. The control  
19 module configured to selectively control the telephone interface to (i) the telephone link connected  
20 state to facilitate receipt of incoming calls by the at least one telephony device, and (ii) the telephone  
21 link disconnected state to facilitate provision of the at least one telephony service to the at least one  
22 telephony device.

## BRIEF DESCRIPTION OF THE DRAWINGS

This invention is pointed out with particularity in the appended claims. The above and further advantages of this invention may be better understood by referring to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 depicts a home area network including a telephony services provider arrangement providing an interface to the public switched telephony network (PSTN), constructed in accordance with the invention;

FIG. 2 is a functional block diagram of the PSTN interface useful in the home area network depicted in FIG. 1; and

FIG. 3 is a flow chart of operations performed by the PSTN interface in which the invention.

## DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

FIG. 1 depicts a home area network 10 including an telephony services provider arrangement that provides an interface to the public switched telephony network (PSTN), constructed in accordance with the invention. Generally, the home area network 10 facilitates the connection of a plurality of household appliances, devices, television and radio receivers, telephone sets, and other facilities (generally "devices") 11(1) through 11(N) (generally identified by reference numeral 11(n)) to a home server 12 over one or more digital communication links generally identified by reference numeral 13 and analog communication links generally identified by reference numeral 14. The home server 12 can also connect to a number of external connections, including a central office in the public switched telephony network (PSTN) over a PSTN link 23, a network such as the Internet over a network link 20, a cable connection (for use in providing cable

1 television, telephony, Internet and other services as will be apparent to those skilled in the art) over  
2 cable link 22, a compact disk player over a compact disk link 21, a barcode reader over barcode link  
3 24, and perhaps other devices (such as devices providing information via satellite and the like, home  
4 security devices, and so forth) over other links generally identified by reference numeral 25.

5 As described in, for example, the aforementioned Edson and Tabloski, et al, applications, the  
6 devices 11(n) can transfer information among themselves over the respective communication link  
7 13, 14 to which they are connected. In addition, the devices 11(n) connected to one communication  
8 link 13, 14 can transfer information to devices connected to another communication link 13, 14 and  
9 between the devices 11(n) and the PSTN, network, cable, etc., through the server 12; in that  
10 operation, if one device 11(n') is connected to an analog communication link 14 and another device  
11 11(n'') (n'≠n'') is connected to a digital communication link 13, the server 12 can perform a digital  
12 to analog or analog to digital conversion as necessary. In addition, the server 12 operates to store  
13 information received from the PSTN, network, cable, and devices 11(n) for later transmission over  
14 the PSTN, network, cable, etc., and later transmission to the devices 11(n). The information  
15 transferred over communication links 13 is preferably in digital form, as is the information stored  
16 on the server. On the other hand, information may be transferred over other connections in digital  
17 or analog form as appropriate.

18 The devices 11(n) that can be connected to the home area network 10 can include a number  
19 of types of appliances, including but not limited to devices such as personal computers, personal  
20 digital assistant (PDA) devices, telephony devices (illustratively device 11(N)), and home  
21 entertainment devices such as radio and television receivers, DVD, compact disk, video and audio  
22 tape and record players, and the like. In addition, devices 11(n) that can be connected to the home  
23 area network can include lighting, heating and cooling, and similar systems, as well as appliances  
24 such as stoves and ovens. If a particular device is a "legacy" device, that is, a device that itself does  
25 not have an interface that can be connected to a digital communication link 13, that legacy device  
26 can be provided with a suitable interface to allow it to be so connected.

1 Generally, the home area network 10 operates to allow information to be stored on the server  
2 12, transferred among the devices 11(n), and transferred from or to a number of external sources or  
3 destinations, including, for example, sources or destinations over a network such as the Internet or  
4 the public switched telephony network (PSTN), cable or satellite television or radio, music sources  
5 such as compact disks. The information may comprise any form of information, including, for  
6 example, audio information, image and video information, information in text form, control  
7 information for, for example, controlling one device from another or from the server 12 in relation  
8 to, for example, occurrence of certain events, computer programs, and so forth. The home area  
9 network can be used to, for example, transfer audio information from sources to destinations such  
10 as the server 12 for storage or to various devices 11(n) for playing. Similarly, the home area network  
11 10 can be used to transfer image or video information from sources to destinations such as the server  
12 12 for storage or to various devices 11(n) for display. In addition, the home area network 10 can be  
13 used to transfer control information to control controllable devices, such as lighting, appliances such  
14 as stoves and ovens, heating and cooling systems, alarm systems and the like.

15 The communication links 13, 14 may be in any form, including a hard link such as a wire,  
16 optical fiber or other arrangement for transferring electrical, optical or other signals among the  
17 appliances. Alternatively or in addition, communication links 13, 14 may comprise wireless links,  
18 such as but not limited to infrared links or links provided by signals in other parts of the electro-  
19 magnetic spectrum. Communication links 13, 14 may comprise communication links specially  
20 provided for the home area network 10, and/or they may include pre-existing links such as telephone  
21 lines, wiring provided for, for example, AC power distribution, and the like.

22 Each device 11(n) connected to a digital communication link 13 preferably includes or is  
23 provided with an interface (not separately shown) that enables it to transmit information, in the form  
24 of message packets to, and/or receive information in the form of message packets from each other  
25 and the home server 12 over the respective communication link 13. When a device 11(n) receives  
26 message packets containing information, it can use the information as described below.

1 Generally, the server 12 includes a number of components (not separately shown),  
2 including components for processing, storing and retrieving data in digital form, and for  
3 converting data between digital and analog form. With particular reference to the present  
4 invention, the server 12 also includes an interface 30 to the PSTN link 23 that facilitates  
5 connection of telephony devices thereto through the server 12. The telephony devices may  
6 be any type of devices that may make use of the PSTN and telephony services, including, for  
7 example, voice telephone devices, facsimile ("fax") machines, personal computers, and so  
8 forth, for placing and receiving telephone calls involving voice, fax and data  
9 communications. The server 12 provides a number of services, including, for example,  
10 automatic answering and recording of messages, providing a plurality of voice mailboxes,  
11 and the like. In addition, if a telephone call is received, the server 12 can provide a  
12 notification to any device 11(n) connected thereto, including, for example, a notification for  
13 display on a television receiver or personal computer that may be connected to a  
14 communication link 13, 14. If the telephone subscriber is also subscribing to the caller  
15 identification service, in which the PSTN provides the identification of callers, the displayed  
16 notification may also include the identification of the caller.

17 The telephone interface 30 provides an arrangement whereby the telephony devices  
18 connected to the server 12 are preferably normally connected to the PSTN link 23 so that,  
19 when a call is received, and if a user desires to answer it, he or she may do so. The telephone  
20 interface 30 also allows the server 12 to monitor the status of an incoming call so that, if the  
21 user does not answer the call, the server 12 may answer the call and record a message. In  
22 addition, if the user is also subscribing to the caller identification service, the server 12 can  
23 receive the caller identification information and display it along with the call notification as  
24 described above. On the other hand, the telephone interface 30 also provides an arrangement  
25 whereby the telephony devices can be disconnected from the PSTN link 23 to, for example,  
26 enable a user to listen to messages that have been recorded by the server 12, manage

1 messages, establish and manage voice mailboxes established on the server 12 to receive  
2 messages for various individuals, and otherwise manage telephony and other services  
3 provided by the server 12 using conventional telephony devices that are connected to the  
4 server.

5 FIG. 2 depicts a functional block diagram of a telephone interface 30 in accordance  
6 with the invention. With reference to FIG. 2, telephone interface 30 connects to the PSTN  
7 link 23 and to one or more telephony devices 31(1) through 31(N) (generally identified by  
8 reference numeral 31(n) over an analog communication link, identified in FIG. 2 by  
9 reference numeral 32. The telephony devices 31(n) can be any conventional telephony  
10 devices, and may include devices that dial using DTMF (dual-tone multiple-frequency)  
11 tones, dial pulses and the like. The telephone interface 30 includes a number of elements,  
12 including a selector switch 33, a modem 34, an RS232 converter 36, a ring detector 37, and  
13 a subscriber line interface card 41.

14 Generally, the selector switch 33, under control of signals from the server's processing  
15 components, controls the connection and disconnection of the communication link 32 and  
16 modem 34 to the PSTN link 23. When the selector switch 33 is in the PSTN link connected  
17 state, in which the communication link 32 and modem 34 are connected to the PSTN link 23,  
18 the telephony devices 31(n) can receive and place telephone calls over the PSTN link 23.  
19 In that PSTN link connected state, the modem 34 is also connected to the PSTN link 23 and,  
20 if the subscriber does not answer an incoming call, the modem 34 can answer the call,  
21 provide an "out-going message" to the calling party and, if the calling party leaves a message,  
22 receive the message and enable the message from the calling party to be stored on the server  
23 12.

24 On the other hand, when the selector switch 33 is in the PSTN link disconnected state,  
25 in which the communication link 32 and modem 34 are not connected to the PSTN link 23,



1 the telephony devices 31(n) cannot receive or place telephone calls over the PSTN link 23.  
2 Instead, the communication link 32 is connected to the modem 34. In that condition, a user,  
3 using the telephony device 31(n) can control the modem 34 to enable the retrieval of  
4 previously recorded messages, record an out-going message, and control the various  
5 telephony services provided by the server 12. In that state, the communication link 32 and  
6 modem 34 are also connected to the subscriber line interface card 41, which can provide  
7 electric power to facilitate communication between the communication link 32 and modem  
8 34. In addition, as will be described below, if another party attempts to place a call to the  
9 PSTN link 23, the ring detector 37 detects the ring signal that the telephone central office  
10 provides over the PSTN link 23 and provides a notification to the server's processor. The  
11 processor, in turn, can enable a notification that an incoming call is being received to be  
12 provided over the communication link 32, and the user can determine whether to take the  
13 call. If the user decides to take the call, he or she can enable the selector switch 33 to return  
14 to the PSTN link connected state. The selector switch 33 is under control of the server's  
15 processor, and may be transitioned from the PSTN link connected state to the PSTN link  
16 disconnected state, and from the PSTN link disconnected state to the PSTN link disconnected  
17 state in response to, for example, control codes input by a user through a keypad that is  
18 normally provided on a telephony device to facilitate dialing.

19 The selector switch 33 includes two switch sections 33C and 33M, both of which are  
20 controlled in tandem by the server's processing components (not separately shown). Each  
21 switch section is a double pole-double throw switch. Switch section 33C includes six  
22 terminals, including a terminal pair generally identified by reference numeral 33C(1) that  
23 connects to the wires comprising communication link 32 and a terminal pair 33C(2) that  
24 connects to the wires comprising PSTN link 23. Similarly, switch section 33M includes  
25 three terminals, including a terminal pair 33M(1) that connects to wires connected the  
26 modem 34 and a terminal pair 33M(2) that connects to wires connected to the PSTN link 23.

1 Terminal pairs 33C(3) and 33M(3) of the switch sections 33C and 33M are connected  
2 together and to the subscriber line interface card 41. Each switch section has a pole pair  
3 33CP and 33MP that are affixed to respective terminal pair 33C(1) and 33C(2) and that can  
4 be selectively connected to respective terminal pair 33C(2), 33M(2) or 33C(3), 33M(3).  
5 When the pole pairs 33CP and 33MP are connected to terminal pairs 33C(2) and 33M(2), the  
6 selector switch 33 is in the PSTN link connected state and, when the pole pairs 33CP and  
7 33MP are connected to terminal pairs 33C(3) and 33M(3), the selector switch 33 is in the  
8 PSTN link disconnected state. As noted above, the pole pairs 33CP and 33MP are controlled  
9 in tandem, with both pole pairs 33CP and 33MP being connected to respective terminal pairs  
10 33C(2) and 33M(2) simultaneously, or to respective terminal pairs 33C(3) and 33M(3)  
11 simultaneously. The pole pairs 33CP and 33MP will not be connected to respective terminal  
12 pairs 33C(2) and 33M(3) simultaneously, or to respective terminal pairs 33C(3) and 33M(2)  
13 simultaneously.

14 When the selector switch 33 is in the PSTN link connected state, since the pole pair  
15 33CP of the switch section 33C connects between terminal pairs 33C(1) and 33C(2), the  
16 telephone interface 30 is in condition to allow incoming calls to be coupled to the  
17 communication link 32, where they may be received through the telephone devices 31(n).  
18 Similarly, since the pole pair 33MP of the switch section 33M connects between terminal  
19 pairs 33M(1) and 33M(2), the telephone interface 30 is in condition to allow incoming calls  
20 to be coupled to the modem 34. As will be described below, if an incoming call is not  
21 answered by a telephone device, the modem 34, under control of the server's processor, will  
22 answer the call, provide an outgoing message, receive an incoming message if the calling  
23 party desires to leave one, and provide the incoming message to the server's storage for later  
24 retrieval. In addition, when the calling party goes on hook, the modem 34 can go on-hook,  
25 thereby to allow another incoming call to be received or to allow a call to be placed through  
26 the telephone devices 31(n). Alternatively, if the server is conditioned to provide a

1 maximum time period for incoming messages, if the calling party's message reaches the  
2 maximum time period, the processor can enable the modem 34 to go on-hook to terminate  
3 the call.

4 Similarly, when the selector switch 33 is in the PSTN link connected state, since the  
5 pole pair 33CP of the switch section 33C connects between terminal pairs 33C(1) and  
6 33C(2), if a user who wishes to make a call takes a telephone device 31(n) off hook and  
7 enters a telephone number, the number will be received by the central office and processed  
8 in a conventional manner. Similarly, if the user, through the telephone device's keypad, enter  
9 predetermined control codes, which are typically prefixed by the tone provided by, for  
10 example, the "star" ("\*") key, followed by tones provided by one or more number keys, the  
11 central office can be enabled to enable, disable or otherwise control telephony services that  
12 are provided to the telephone subscriber by the central office.

13 It will be appreciated that, when the selector switch 33 is in the PSTN link connected  
14 state, control codes entered by the user will also be coupled by the switch section 33M to the  
15 modem 34. As will be described below, if the user enters a control code, the modem 34 will  
16 notify the processor and, if the user enters a predetermined control codes, the server's  
17 processor can enable operations related to the server's call answering services to be provided,  
18 which may include, for example, retrieval and playing of previously-recorded messages,  
19 deletion of messages, creation of mailboxes, recording of outgoing messages and the like.  
20 If the user enters a call answering control code, the processor may enable the selector switch  
21 33 to switch to the PSTN link disconnected state. When the selector switch 33 is in the  
22 PSTN link disconnected state, since the pole pair 33CP of the switch section 33C connects  
23 between terminal pairs 33C(1) and 33C(3) and the pole pair 33MP of the switch section 33M  
24 connects between terminal pairs 33M(1) and 33M(3), the telephone interface 30 connects the

1 communication link 32 to the modem 34, while disconnecting the PSTN link 23 from the  
2 communication link 32 and modem 34. Since the communication link 32 and modem 34  
3 are disconnected from the PSTN link 23, telephone calls that are placed to the PSTN link 23  
4 will not be received by either a telephone device 31(n) connected to the communication link  
5 32 or the modem 34.

6 However, as is apparent, in the PSTN link disconnected state, the communication link  
7 32 is connected to the modem 34, as well as to the subscriber line interface card 41. In that  
8 case, subsequent input provided by the user through the keypad of the respective telephone  
9 device 31(n) will be provided only to the modem 34, and, since the communication link 32  
10 and modem 34 are isolated from the PSTN link 23, without the interruption of the dial tone  
11 that is provided by the central office on PSTN link 23. In addition, as noted above, if, while  
12 the selector switch 33 is in the PSTN link disconnected state, the processor receives a  
13 notificatin from the ring detector 37 indicating that the central office has placed a ring signal  
14 on the PSTN link 23, which will be the case if another party attempts to place a call to the  
15 PSTN link 23 as called party, the ring detector 37 will detect the ringing signal and provide  
16 a notification to the server's processor. When that occurs, the server 12 can provide a  
17 notification of the call over the communication link 32 to allow the user to determine  
18 whether to take the call. It will be appreciated that the ring detector 37 will also provide  
19 notifications of incoming calls to the processor while the selector switch is in the PSTN link  
20 connected state when the central office provides a ring signal on PSTN link 23, and, in that  
21 case the processor can select to make use of one or both of the notifications provided by the  
22 ring detector or the notifications provided by the modem 34.

23 The server's processor can also be enabled to provide at least some of the telephony  
24 services (that is, enabling a user to listen to messages that have been recorded by the server  
25 12, manage messages, establish and manage voice mailboxes, and otherwise manage

1 telephony and other services provided by the server 12) provided thereby when the telephone  
2 interface 30 is in the PSTN link connected state in response to a call received over the PSTN  
3 link 23, particularly if the incoming call is not answered by a telephony device 31(n). In that  
4 case, if the modem 34 receives one or more control codes, it can notify the processor, which  
5 can provide the respective services in a manner similar to the manner in which it provides  
6 the respective service when requested through a telephony device 31(n). It will be  
7 appreciated that the processor may require an authentication code, password or other  
8 identifier to be provided by the calling party before the various services will be provided.

9 As noted above, if an incoming call is received and not answered while the selector  
10 switch 33 is in the PSTN link connected state, the modem 34 can answer the call, provide an  
11 outgoing message, and receive messages from the calling party and enable them to be stored.  
12 In addition, the modem 34 can, under control of a telephony device 31(n), enable messages  
13 to be retrieved and provided thereto for playing. The modem 34 is preferably a  
14 data/fax/voice modem that can receive digital data, facsimile and voice communications in  
15 analog form over the PSTN link 23 and provide a digital DIGITIZED AUDIO OUT signal  
16 representing digital data for storage by the server's storage components. Similarly, the  
17 modem 34 can receive a digital DIGITIZED AUDIO IN signal representing digital data  
18 retrieved from the server's storage components and convert the data to analog audio form for  
19 transmission through the switch section 33M. If the selector switch 33 is in the PSTN link  
20 connected state, the analog audio signal provided by the modem 34 will be transmitted both  
21 over the PSTN link 23 and the communication link 32. On the other hand, if the selector  
22 switch is in the PSTN link disconnected state, the analog audio signal provided by the  
23 modem 34 will be transmitted over only the communication link 32.

24 The modem 34 also provides status information to the server's processor components.  
25 The status information is provided as a SERIAL DATA signal, which is coupled to the

1 server's processor through the RS232 converter 36. The status information can notify the  
2 processor that a call is being received and the status of the call, including, for example, if the  
3 call is answered by one of the telephone devices. In addition, if the telephone subscriber has  
4 subscribed to the caller identification service, the status information can provide the caller  
5 identification to the processor. The processor can use the status information indicating that  
6 a call is being received and the caller identification to, for example, provide a notification to  
7 a device 11(n) as described above. The call status information can, for example, include ring  
8 information that can be used by the processor to determine whether a telephone device 31(n)  
9 has gone off-hook within a predetermined number of rings to answer an incoming call, and,  
10 if not, initiate call answering to facilitate recording of a message. The call status information  
11 can also include call termination information that, if a message is being recorded, the  
12 processor can determine the message has ended.

13 With this background, operations performed by the telephone interface 30 in  
14 connection with receiving a call and in responding to a request from a user through a  
15 telephone device 31(n) regarding recorded messages will be described in connection with  
16 FIG. 2 and the flow chart depicted in FIG. 3. Generally, in the telephone interface 30, the  
17 selector switch 33 will initially be in the PSTN link connected state, with the pole pair 33CP  
18 of switch section 33C interconnecting the terminal pairs 33C(1) and 33C(2) and pole pair  
19 33MP of switch section 33M interconnecting the terminal pairs 33M(1) and 33M(2). In that  
20 condition, calls placed to the PSTN link 23 by a calling party will be completed by the  
21 central office to the PSTN link 23, and, when the modem 34 receives a signal from the  
22 switch section 33M, it will initially determine whether the signal is representative of a ring  
23 signal from the central office or a control code, the control code comprising a DTMF signal  
24 from a telephony device 31(n) for use by the server 12 (step 100). If the modem 34  
25 determines that the signal is a representative of a ring signal from the central office, it will  
26 initially provide call status information to the processor indicating that a new call is being

1 received (step 101). In addition, if the modem 34 receives caller identification information,  
2 it can provide the caller identification information to the processor (step 102). After the  
3 processor is notified that a new call is being received, it can enable a notification of the call  
4 to be displayed or otherwise signaled by one or more of the devices 11(n), along with any  
5 received caller identification information (step 103). It will be appreciated that, the  
6 telephony devices 31(n) will also receive the ring signal and, if one or more of them have  
7 ringers or other devices for providing an audible notification, they may be actuated to  
8 produce the audible notification. In addition, the telephony devices 31(n) will also receive  
9 the caller identification information, and if one or more of the telephony devices have  
10 displays for displaying caller identification information, they may be actuated to display the  
11 caller identification information.

12 The modem 34, for each ring signal received thereby, provides call status information  
13 to the processor indicating that a ring signal had been received (step 104). Each time the  
14 processor receives call status information from the modem 34 indicating that a ring signal  
15 has been received, it will determine whether the number of ring signals received exceeds a  
16 predetermined threshold value (step 105), and, if not events return to step 104 to allow the  
17 modem to wait for the next ring signal to be received. It will be clear from the following that  
18 the predetermined threshold value will correspond to the number of rings at which the server  
19 12 will answer the call and allow the calling party to leave a message.

20 The modem 34 and processor will sequence through steps 104 and 105 for a number  
21 of iterations until either a user answers the call or the processor determines that the number  
22 of ring signals that have been received exceeds the predetermined threshold value. If the  
23 processor determines that the number of ring signals that have been received exceeds the  
24 predetermined threshold value, it proceeds to a sequence in which it enables the modem to  
25 provide an outgoing message and for transmission over the PSTN link 23, and to receive a

1 message and provide a digitized version thereof to storage for later retrieval. In the  
2 following, it will be assumed that the server 12 provides a plurality of mailboxes, and that  
3 a calling party who wishes to leave a message can identify the mailbox that is to receive the  
4 message by depressing a key on the keypad of his or her telephony device (not shown) to  
5 provide a DTMF control code. In those operations, the processor will enable the modem to  
6 go off-hook to answer the call (step 106) and will enable digital data representing the  
7 outgoing message to be retrieved from server storage and provided to the modem 34 as the  
8 DIGITIZED AUDIO IN signal (step 107). The modem 34 converts the DIGITIZED AUDIO  
9 IN signal to analog form and transmit it to the calling party over the PSTN link 23 (step 108).  
10 If the modem 34 receives a DTMF control code identifying the mailbox into which a  
11 subsequently received message is to be stored, it provides the control code to the processor  
12 (step 109). Thereafter, the calling party can provide a message in analog form, which the  
13 modem 34 converts to digital form and couples to the storage as digital DIGITIZED AUDIO  
14 OUT signal (step 110). The storage will store the digital information provided thereto in  
15 storage locations as determined by the processor (step 111) and the processor will associate  
16 the message with the mailbox identified by the control code provided thereto in step 109  
17 (step 112).

18 When the calling party hangs up (step 113), the modem 34 provides call status  
19 information to the processor indicating that the calling party has gone on-hook and the call  
20 terminated (step 114), after which the processor can terminate recording of the message, if  
21 any, and enable the modem 34 to go to the on-hook condition to terminate the call (step 115).  
22 It will be appreciated that the calling party may also go on-hook without leaving a message  
23 and even during the ring sequence while the ring signals are being received. In that case, if  
24 the calling party hangs up during the ring sequence, before the modem has gone off-hook and  
25 answered the call, the modem 34 need merely provide call status information to the processor  
26 indicating that the calling party has gone on-hook and otherwise ignore the call. On the other



1 hand, if the calling party hangs up after the modem 34 has gone off-hook, but without leaving  
2 a message, the modem 34 can provide call status information to the processor indicating that  
3 the calling party has gone on-hook, and the processor can enable the modem 34 to return to  
4 the on-hook condition.

5         Returning to step 100, if the modem 34 determines in that step that the signal received  
6 from the selector switch 33 is a DTMF control code, it will step to a sequence in which the  
7 control code is processed. As noted above, the DTMF control code may comprise a control  
8 code to control a telephony service provided by the central office, or alternatively it may  
9 control a telephony service provided by the server 12, such as retrieving and playing  
10 previously-stored messages, recording an outgoing message, and other services as will be  
11 apparent to those skilled in the art. Typically, DTMF control codes include a prefix tone  
12 corresponding to the telephony device's "star" ("\*") and/or "pound" ("#") key followed by one  
13 or more tones corresponding to the telephony device's numerical keys. In the following it  
14 will be assumed that, to make use of any of the telephony services provided by the server 12,  
15 the user will initially enter a DTMF control code that enables the server 12 to, in turn,  
16 condition the selector switch 33 to the PSTN link disconnected state, and thereafter enters  
17 one or more DTMF control codes to enable the server 12 to provide the particular telephony  
18 service or services desired by the user. By providing that the selector switch 33 initially  
19 switch from the PSTN link connected state to the PSTN link disconnected state, thereby  
20 disconnecting the communication link 32 and the modem 34 from the PSTN link 23, it will  
21 be appreciated that the user can make use of the telephony services provided by the server  
22 12 without the possible annoyance of the dial tone provided by the central office on the  
23 PSTN link 23, and in addition will further ensure that subsequent DTMF control codes input  
24 by a user are not received and erroneously used by the central office. It will be appreciated  
25 that the DTMF control code provided by the user to enable the server 12 to condition the

1 selector switch to the PSTN link disconnected state will preferably not correspond to a  
2 DTMF control code used by the central office in providing a telephony service.

3 In any case, after the modem 34 determines in step 100 that it has received a DTMF  
4 control code, it will provide the DTMF control code as CALL STATUS signals to the  
5 processor (step 120). The processor will determine whether the DTMF control code is the  
6 control code to enable the selector switch 33 to be conditioned to the PSTN link disconnected  
7 state (step 121). If the processor makes a positive determination in step 121, it will enable  
8 the selector switch 33 to be conditioned to the PSTN link disconnected state (step 122).  
9 When the modem 34 receives a subsequent DTMF control code in step 100, which will  
10 identify the type of telephony service to be provided by the server 12, it will also provide the  
11 DTMF control code to the processor which will determine the type of telephony service to  
12 be provided. If the processor determines that the telephony service is the playback of  
13 previously recorded messages (step 123), it will determine whether there are any messages  
14 to be played (step 124) and, if so, enable them to be retrieved from storage and provided to  
15 the modem 34 as the ANALOG AUDIO IN signal (step 125). The modem 34, in turn, will  
16 convert the digital message information that it received from storage to analog form for  
17 transmission over the communication link 32 (step 126). The user can hear the messages on  
18 the telephony device that he or she is using. When the user hangs up (step 127), the modem  
19 34 will provide a notification thereof as the CALL STATUS signal to the processor (step  
20 128), and the processor can, in turn, terminate message retrieval, if all of the messages have  
21 not been retrieved (step 129), and, if the selector switch 33 is in the PSTN link disconnected  
22 state, enable it to return to the PSTN link connected state (step 130). It will be appreciated  
23 that, after the messages have been played and before the user hangs up, the processor may,  
24 in the same manner that it provides the previously-recorded messages, provide a message to  
25 the user notifying him or her of other options, that is, other telephony services provided by  
26 the server 12, and allow him or her to initiate another telephony service prior to hanging up.

1           Returning to step 124, if the processor determines in that step that there are no  
2 messages to be played, it can enable a suitable notification to be provided to the user (step  
3 131). For example, if the notification is to be an audible notification, such as a beep or  
4 spoken notification, the processor can enable the digital signal therefor to be provided to the  
5 modem 34 as the DIGITIZED AUDIO IN signal, which the modem 34 can convert the  
6 digital signal to analog form for transmission over the communication link 32 in the same  
7 manner as a previously-recorded message.

8           It will be appreciated that, if the server 12 provides multiple mailboxes in which  
9 messages may be stored, the processor, prior to determining whether there are any messages  
10 to be played (reference step 125) can enable a audio notification to be played requesting the  
11 identification of the mailbox from which messages are to be played, and allow the user to  
12 provide the identification. In those operations, the processor will enable digital data  
13 representing the audio notification to be provided to the modem 34 as the DIGITIZED  
14 AUDIO IN signal, which the modem 34 can convert the digital signal to analog form for  
15 transmission over the communication link 32 in the same manner as a previously-recorded  
16 message. The user can use the telephony device's keypad to provide DTMF signals that  
17 identify the mailbox from which messages are to be played, and the modem 34 can provide  
18 the DTMF tone information to the processor as the CALL STATUS signal. The processor  
19 can thereafter use the CALL STATUS signal to determine the mailbox from which messages  
20 (if any) are to be retrieved.

21           Returning to step 123, if the processor determines that the DTMF control code is not  
22 one to enable retrieval of messages, it can sequence to step 140 to determine whether the  
23 DTMF control code is to enable an outgoing message to be recorded. If the processor makes  
24 a positive determination in step 140, it will enable the modem 34 to provide a notification  
25 to the user that he or she should begin speaking and thereafter enable the modem to convert

1 the outgoing message from analog form to digital form and the digitized message to be  
2 stored. More specifically, following step 140, the processor will enable the notification that  
3 the user should begin speaking to be coupled, in digital form, to the modem 34 (step 141),  
4 which converts the notification to analog form for transmission to the user's telephony device  
5 31(n) over the communication link 32 (step 142). Thereafter, as the user provides the  
6 outgoing message (step 143), the modem 34 will receive the outgoing message in analog  
7 form and convert it to digital form as the DIGITIZED VOICE OUT signal (step 144), which  
8 the processor will enable to be stored for future use (step 145). When the user hangs up  
9 otherwise terminates the outgoing message (step 146), the modem 34 will provide a  
10 notification thereof as the CALL STATUS signal to the processor (step 147), and the  
11 processor can, in turn, terminate storage of the digitized outgoing message (step 148), and  
12 enable the selector switch 33 to return to the PSTN link connected state and open the make  
13 busy relay 37 (step 149). It will be appreciated that, after the outgoing message has  
14 terminated and before the user hangs up, the processor may, in the same manner that it  
15 provides the previously-recorded messages, provide a message to the user notifying him or  
16 her of other options, that is, other telephony services provided by the server 12, and allow  
17 him or her to initiate another telephony service prior to hanging up.

18 Returning to step 140, if the processor determines in that step that the DTMF control  
19 code is not to enable an outgoing message to be recorded, it will proceed to step 160 to  
20 determine whether the DTMF control code is for another telephony service provided by the  
21 server 12, and, if so, it and the elements of the telephone interface 30 will operate to provide  
22 the service in a manner similar to that described above, as adjusted for the respective service  
23 (step 161), and thereafter the selector switch 33 to will be conditioned to return to the PSTN  
24 link connected state and open the make busy relay 37 (step 162). It will be appreciated that,  
25 after the service has been provided and before the user hangs up, the processor may, in the  
26 same manner that it provides the previously-recorded messages, provide a message to the

1 user notifying him or her of other options, that is, other telephony services provided by the  
2 server 12, and allow him or her to initiate another telephony service prior to hanging up.

3 It will also be appreciated that, if the processor made a negative determination in step  
4 123, it may require authentication indicia to be provided before permitting steps 127 through  
5 162 to be performed.

6 If the ring detector 37 receives a ringing signal indicating that an incoming call is  
7 being received over the PSTN link 23 (step 170), it can notify the processor (step 171). The  
8 processor, in turn, after it receives the notification from the ring detector 37, can determine  
9 whether the selector switch 33 is in the PSTN link disconnected state (step 172). If the  
10 processor makes a positive determination in step 172, it can provide an audible notification  
11 over the communication link 32 that an incoming call is being received (step 173). If the  
12 user thereafter enters an appropriate DTMF control code to indicate that he or she wishes to  
13 receive the incoming call, the modem 34 can provide a corresponding notification to the  
14 processor (step 174), which, in turn, will terminate message retrieval, if all of the messages  
15 have not been retrieved (step 175), and enable the selector switch 33 to return to the PSTN  
16 link connected state to allow the user to take the call (step 176). As noted above, if the  
17 processor makes a negative determination in step 172, it can ignore the notification from the  
18 ring detector 37.

19 The invention provides a number of advantages. In particular, the invention provides  
20 a telephone interface 30 for a server 12 in a home area network 10 that interfaces telephony  
21 devices in the home to the public switched telephony network (PSTN), and that provides  
22 various telephony services. In addition, it does so in such a manner that, if the server 12  
23 malfunctions, or is powered down, since the selector switch's default state is the PSTN link  
24 connected state, the telephony devices 31(n) will still be able to access the PSTN through the  
25 telephone interface 30.

1 It will be appreciated that numerous modifications may be made to the telephone  
2 interface 30 as described herein. For example, the information represented by the CALL  
3 STATUS signal may be provided to the processor using a variety of methodologies. In  
4 addition, the telephone interface 30 can be provided without a home network adapter 40 or  
5 a ring detector 37. It will be appreciated however, that, if a ring detector 37, or component  
6 that serves a similar purpose, is not provided, if a calling party attempts to place a call to the  
7 PSTN link while the selector switch 33 is in the PSTN link disconnected state, the user will  
8 not be notified if another party attempts to place a call to the PSTN link 23.

9 As another modification, instead of or in addition to a ring detector 37, the telephone  
10 interface 30 can be provided with a make busy relay (not separately shown) that, when the  
11 processor enables the selector switch 33 to go into the PSTN link disconnected mode, it can  
12 also enable the make busy relay to go into a condition that will cause the central office to  
13 believe that the PSTN link 23 is open so that the central office will mark the PSTN link 23  
14 as busy. The make busy relay has two states, an open state and a busy state, which can be  
15 controlled by the server's processor. The make busy relay can essentially force the PSTN  
16 central office to recognize the PSTN link 23 as being in an off-hook condition, even if none  
17 of the telephone devices 31(n) are in the off-hook condition, so that the telephone subscriber  
18 line will be in the busy condition. The default condition of the make busy relay is the open  
19 state, in which the central office will mark the PSTN link 23 as not being busy. In that case,  
20 when a calling party attempts to place a call to the PSTN link 23 as the called party, the  
21 central office will complete the call. On the other hand, when the processor conditions the  
22 make busy relay to the busy condition, the make busy relay will close to condition the  
23 PSTN link 23 so as to enable the central office to mark the PSTN link 23 as being busy. In  
24 that case, if a calling party attempts to wishes to place a call to the PSTN link 23 as the called  
25 party, the central office will not complete the call, but instead will provide a busy tone to the  
26 calling party indicating that the line is busy.

1 In one embodiment, in which the PSTN link 23 comprises two physical wires, when  
2 the make busy relay is in the open state, it will provide an open circuit therebetween. On  
3 the other hand, when the make busy relay is in the make busy state, it will close a circuit  
4 between the two wires in a manner similar to that performed by a telephone device 31(n)  
5 when it goes off hook. Since the central office provides a current between the two wires,  
6 it can detect when the make busy relay goes into the make busy state by noting the increase  
7 in current in the circuit formed between the two wires.

8 The processor can enable the make busy relay to go into the make busy state when,  
9 for example, the selector switch 33 goes into the PSTN link disconnected state. In that case,  
10 when a calling party places a call to the PSTN link 23 while, for example, a user is retrieving  
11 previously-stored messages, the central office will provide a busy signal to the calling party.

12 FIG. 4 schematically depicts a portion of a second embodiment of a telephone  
13 interface, identified by reference numeral 230. The telephone interface 230 provides an  
14 arrangement for providing subscriber loop current that may be necessary to allow certain  
15 types of telephony devices to be used with the server 12. Generally, the telephone central  
16 office provides a subscriber loop current that may be required by those types of telephony  
17 devices to power certain functions, such as ringing, DTMF signal generation, and so forth.  
18 Other types of telephony devices may provide their own power, obtained from, for example,  
19 electrical batteries, AC power, or the like, and may not need power from the telephone  
20 central office for those functions. To facilitate use of types of telephony devices that do  
21 require power from a central office, the telephone interface 230 also provides an arrangement  
22 for providing subscriber loop current to those telephony devices, illustratively, telephony  
23 device 231.

24 With reference to FIG. 4, the telephone interface 230 also includes a selector switch  
25 233 for selectively connecting the telephony device 231 and a modem 234 to, or

1 disconnecting them from, the PSTN link 23. As noted above, the PSTN link 23,  
2 communication link 32, and so forth, depicted in FIG. 2 actually comprise two wires, and in  
3 FIG. 4 the wires comprising the respective links 23, 232, and so forth, are depicted explicitly  
4 and distinguished by indices "a" and "b". In addition, as noted above, the selector switch 33  
5 is a double pole-double throw switch, and in FIG. 4 the respective double terminals and poles  
6 of the respective switches 233C and 233M are depicted explicitly and distinguished by  
7 indices "a" and "b". The telephone interface 230 is also provided with an arrangement 240  
8 that provides subscriber loop current, including current sources 241 and 242 and a capacitor  
9 243. Current source 241 is connected to terminal 233C(3)(a) of switch 233C, and current  
10 source 242 is connected to terminal 233M(3)(a) of switch 233M. Capacitor 243 is connected  
11 between terminals 233C(3)(b) and 233M(3)(b) of switches 233C and 233M and provides an  
12 AC (alternating current) short for audio frequencies. Terminals 233C(3)(b) and 233M(3)(b)  
13 are connected together. Current source 241 is connected to a positive voltage source to  
14 provide current, and current source 242 is connected to a negative voltage source to sink  
15 current. When, as depicted in FIG. 4, the selector switch 233 is in the PSTN link  
16 disconnected state, the current sources 241 and 242 provide subscriber loop current to the  
17 loop consisting of terminal 233C(3)(a), pole 233CP(a), terminal 233C(1)(a), communication  
18 link wire 232(a), telephony device 231, communication link wire 232(b), terminal  
19 233C(1)(b) pole 233CP(b), terminal 233C(3)(b), terminal 233M(3)(b), pole 233MP(b),  
20 terminal 233M(1)(b), modem 234, terminal 233M(1)(a), pole 233MP(a), and terminal  
21 233M(3)(a). Accordingly, when the selector switch 233 is in the PSTN link disconnected  
22 state, the switch provides a loop to which the loop current arrangement 240 can provide  
23 current.

24 The foregoing description has been limited to a specific embodiment of this invention.  
25 It will be apparent, however, that various variations and modifications may be made to the  
26 invention, with the attainment of some or all of the advantages of the invention. It is the



1 object of the appended claims to cover these and such other variations and modifications as  
 2 come within the true spirit and scope of the invention.

3 What is claimed as new and desired to be secured by Letters Patent of the United  
 4 States is:

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008  
1009  
1010  
1011  
1012  
1013  
1014  
1015  
1016  
1017  
1018  
1019  
1020  
1021  
1022  
1023  
1024  
1025  
1026  
1027  
1028  
1029  
1030  
1031  
1032  
1033  
1034  
1035  
1036  
1037  
1038  
1039  
1040  
1041  
1042  
1043  
1044  
1045  
1046  
1047  
1048  
1049  
1050  
1051  
1052  
1053  
1054  
1055  
1056  
1057  
1058  
1059  
1060  
1061  
1062  
1063  
1064  
1065  
1066  
1067  
1068  
1069  
1070  
1071  
1072  
1073  
1074  
1075  
1076  
1077  
1078  
1079  
1080  
1081  
1082  
1083  
1084  
1085  
1086  
1087  
1088  
1089  
1090  
1091  
1092  
1093  
1094  
1095  
1096  
1097  
1098  
1099  
1100  
1101  
1102  
1103  
1104  
1105  
1106  
1107  
1108  
1109  
1110  
1111  
1112  
1113  
1114  
1115  
1116  
1117  
1118  
1119  
1120  
1121  
1122  
1123  
1124  
1125  
1126  
1127  
1128  
1129  
1130  
1131  
1132  
1133  
1134  
1135  
1136  
1137  
1138  
1139  
1140  
1141  
1142  
1143  
1144  
1145  
1146  
1147  
1148  
1149  
1150  
1151  
1152  
1153  
1154  
1155  
1156  
1157  
1158  
1159  
1160  
1161  
1162  
1163  
1164  
1165  
1166  
1167  
1168  
1169  
1170  
1171  
1172  
1173  
1174  
1175  
1176  
1177  
1178  
1179  
1180  
1181  
1182  
1183  
1184  
1185  
1186  
1187  
1188  
1189  
1190  
1191  
1192  
1193  
1194  
1195  
1196  
1197  
1198  
1199  
1200  
1201  
1202  
1203  
1204  
1205  
1206  
1207  
1208  
1209  
1210  
1211  
1212  
1213  
1214  
1215  
1216  
1217  
1218  
1219  
1220  
1221  
1222  
1223  
1224  
1225  
1226  
1227  
1228  
1229  
1230  
1231  
1232  
1233  
1234  
1235  
1236  
1237  
1238  
1239  
1240  
1241  
1242  
1243  
1244  
1245  
1246  
1247  
1248  
1249  
1250  
1251  
1252  
1253  
1254  
1255  
1256  
1257  
1258  
1259  
1260  
1261  
1262  
1263  
1264  
1265  
1266  
1267  
1268  
1269  
1270  
1271  
1272  
1273  
1274  
1275  
1276  
1277  
1278  
1279  
1280  
1281  
1282  
1283  
1284  
1285  
1286  
1287  
1288  
1289  
1290  
1291  
1292  
1293  
1294  
1295  
1296  
1297  
1298  
1299  
1300  
1301  
1302  
1303  
1304  
1305  
1306  
1307  
1308  
1309  
1310  
1311  
1312  
1313  
1314  
1315  
1316  
1317  
1318  
1319  
1320  
1321  
1322  
1323  
1324  
1325  
1326  
1327  
1328  
1329  
1330  
1331  
1332  
1333  
1334  
1335  
1336  
1337  
1338  
1339  
1340  
1341  
1342  
1343  
1344  
1345  
1346  
1347  
1348  
1349  
1350  
1351  
1352  
1353  
1354  
1355  
1356  
1357  
1358  
1359  
1360  
1361  
1362  
1363  
1364  
1365  
1366  
1367  
1368  
1369  
1370  
1371  
1372  
1373  
1374  
1375  
1376  
1377  
1378  
1379  
1380  
1381  
1382  
1383  
1384  
1385  
1386  
1387  
1388  
1389  
1390  
1391  
1392  
1393  
1394  
1395  
1396  
1397  
1398  
1399  
1400  
1401  
1402  
1403  
1404  
1405  
1406  
1407  
1408  
1409  
1410  
1411  
1412  
1413  
1414  
1415  
1416  
1417  
1418  
1419  
1420  
1421  
1422  
1423  
1424  
1425  
1426  
1427  
1428  
1429  
1430  
1431  
1432  
1433  
1434  
1435  
1436  
1437  
1438  
1439  
1440  
1441  
1442  
1443  
1444  
1445  
1446  
1447  
1448  
1449  
1450  
1451  
1452  
1453  
1454  
1455  
1456  
1457  
1458  
1459  
1460  
1461  
1462  
1463  
1464  
1465  
1466  
1467  
1468  
1469  
1470  
1471  
1472  
1473  
1474  
1475  
1476  
1477  
1478  
1479  
1480  
1481  
1482  
1483  
1484  
1485  
1486  
1487  
1488  
1489  
1490  
1491  
1492  
1493  
1494  
1495  
1496  
1497  
1498  
1499  
1500  
1501  
1502  
1503  
1504  
1505  
1506  
1507  
1508  
1509  
1510  
1511  
1512  
1513  
1514  
1515  
1516  
1517  
1518  
1519  
1520  
1521  
1522  
1523  
1524  
1525  
1526  
1527  
1528  
1529  
1530  
1531  
1532  
1533  
1534  
1535  
1536  
1537  
1538  
1539  
1540  
1541  
1542  
1543  
1544  
1545  
1546  
1547  
1548  
1549  
1550  
1551  
1552  
1553  
1554  
1555  
1556  
1557  
1558  
1559  
1560  
1561  
1562  
1563  
1564  
1565  
1566  
1567  
1568  
1569  
1570  
1571  
1572  
1573  
1574  
1575  
1576  
1577  
1578  
1579  
1580  
1581  
1582  
1583  
1584  
1585  
1586  
1587  
1588  
1589  
1590  
1591  
1592  
1593  
1594  
1595  
1596  
1597  
1598  
1599  
1600  
1601  
1602  
1603  
1604  
1605  
1606  
1607  
1608  
1609  
1610  
1611  
1612  
1613  
1614  
1615  
1616  
1617  
1618  
1619  
1620  
1621  
1622  
1623  
1624  
1625  
1626  
1627  
1628  
1629  
1630  
1631  
1632  
1633  
1634  
1635  
1636  
1637  
1638  
1639  
1640  
1641  
1642  
1643  
1644  
1645  
1646  
1647  
1648  
1649  
1650  
1651  
1652  
1653  
1654  
1655  
1656  
1657  
1658  
1659  
1660  
1661  
1662  
1663  
1664  
1665  
1666  
1667  
1668  
1669  
1670  
1671  
1672  
1673  
1674  
1675  
1676  
1677  
1678  
1679  
1680  
1681  
1682  
1683  
1684  
1685  
1686  
1687  
1688  
1689  
1690  
1691  
1692  
1693  
1694  
1695  
1696  
1697  
1698  
1699  
1700  
1701  
1702  
1703  
1704  
1705  
1706  
1707  
1708  
1709  
1710  
1711  
1712  
1713  
1714  
1715  
1716  
1717  
1718  
1719  
1720  
1721  
1722  
1723  
1724  
1725  
1726  
1727  
1728  
1729  
1730  
1731  
1732  
1733  
1734  
1735  
1736  
1737  
1738  
1739  
1740  
1741  
1742  
1743  
1744  
1745  
1746  
1747  
1748  
1749  
1750  
1751  
1752  
1753  
1754  
1755  
1756  
1757  
1758  
1759  
1760  
1761  
1762  
1763  
1764  
1765  
1766  
1767  
1768  
1769  
1770  
1771  
1772  
1773  
1774  
1775  
1776  
1777  
1778  
1779  
1780  
1781  
1782  
1783  
1784  
1785  
1786  
1787  
1788  
1789  
1790  
1791  
1792  
1793  
1794  
1795  
1796  
1797  
1798  
1799  
1800  
1801  
1802  
1803  
1804  
1805  
1806  
1807  
1808  
1809  
1810  
1811  
1812  
1813  
1814  
1815  
1816  
1817  
1818  
1819  
1820  
1821  
1822  
1823  
1824  
1825  
1826  
1827  
1828  
1829  
1830  
1831  
1832  
1833  
1834  
1835  
1836  
1837  
1838  
1839  
1840  
1841  
1842  
1843  
1844  
1845  
1846  
1847  
1848  
1849  
1850  
1851  
1852  
1853  
1854  
1855  
1856  
1857  
1858  
1859  
1860  
1861  
1862  
1863  
1864  
1865  
1866  
1867  
1868  
1869  
1870  
1871  
1872  
1873  
1874  
1875  
1876  
1877  
1878  
1879  
1880  
1881  
1882  
1883  
1884  
1885  
1886  
1887  
1888  
1889  
1890  
1891  
1892  
1893  
1894  
1895  
1896  
1897  
1898  
1899  
1900  
1901  
1902  
1903  
1904  
1905  
1906  
1907  
1908  
1909  
1910  
1911  
1912  
1913  
1914  
1915  
1916  
1917  
1918  
1919  
1920  
1921  
1922  
1923  
1924  
1925  
1926  
1927  
1928  
1929  
1930  
1931  
1932  
1933  
1934  
1935  
1936  
1937  
1938  
1939  
1940  
1941  
1942  
1943  
1944  
1945  
1946  
1947  
1948  
1949  
1950  
1951  
1952  
1953  
1954  
1955  
1956  
1957  
1958  
1959  
1960  
1961  
1962  
1963  
1964  
1965  
1966  
1967  
1968  
1969  
1970  
1971  
1972  
1973  
1974  
1975  
1976  
1977  
1978  
1979  
1980  
1981  
1982  
1983  
1984  
1985  
1986  
1987  
1988  
1989  
1990  
1991  
1992  
1993  
1994  
1995  
1996  
1997  
1998  
1999  
2000  
2001  
2002  
2003  
2004  
2005  
2006  
2007  
2008  
2009  
2010  
2011  
2012  
2013  
2014  
2015  
2016  
2017  
2018  
2019  
2020  
2021  
2022  
2023  
2024  
2025  
2026  
2027  
2028  
2029  
2030  
2031  
2032  
2033  
2034  
2035  
2036  
2037  
2038  
2039  
2040  
2041  
2042  
2043  
2044  
2045  
2046  
2047  
2048  
2049  
2050  
2051  
2052  
2053  
2054  
2055  
2056  
2057  
2058  
2059  
2060  
2061  
2062  
2063  
2064  
2065  
2066  
2067  
2068  
2069  
2070  
2071  
2072  
2073  
2074  
2075  
2076  
2077  
2078  
2079  
2080  
2081  
2082  
2083  
2084  
2085  
2086  
2087  
2088  
2089  
2090  
2091  
2092  
2093  
2094  
2095  
2096  
2097  
2098  
2099  
2100  
2101  
2102  
2103  
2104  
2105  
2106  
2107  
2108  
2109  
2110  
2111  
2112  
2113  
2114  
2115  
2116  
2117  
2118  
2119  
2120  
2121  
2122  
2123  
2124  
2125  
2126  
2127  
2128  
2129  
2130  
2131  
2132  
2133  
2134  
2135  
2136  
2137  
2138  
2139  
2140  
2141  
2142  
2143  
2144  
2145  
2146  
2147  
2148  
2149  
2150  
2151  
2152  
2153  
2154  
2155  
2156  
2157  
2158  
2159  
2160  
2161  
2162  
2163  
2164  
2165  
2166  
2167  
2168  
2169  
2170  
2171  
2172  
2173  
2174  
2175  
2176  
2177  
2178  
2179  
2180  
2181  
2182  
2183  
2184  
2185  
2186  
2187  
2188  
2189  
2190  
2191  
2192  
2193  
2194  
2195  
2196  
2197  
2198  
2199  
2200  
2201  
2202  
2203  
2204  
2205  
2206  
2207  
2208  
2209  
2210  
2211  
2212  
2213  
2214  
2215  
2